Conclusions.—In normal animals the circulation possesses the ability to get rid readily of a surplus of dextrose injected intravenously. In the absence of the pancreas this ability of the circulation is impaired. This ability can be temporarily restored by an intravenous injection of a pancreas emulsion.

Furthermore, an intravenous injection of a pancreas emulsion is capable of reducing the hyperglycaemia due only to depancreatization to a normal level of the dextrose content of the blood.

As to the nature of the factors which may constitute the ability or inability of the circulation to get rid of a certain degree of surplus of the dextrose content of the blood, we are not willing to discuss it at this stage of our investigation. We are rather bent upon seeing how many more facts we shall be enabled to bring to light on the basis of the hypothesis which set us to work on these problems.

PARTHENOCARPY AND PARTHENOGENESIS IN NICOTIANA

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The occurrence of parthenogenesis in the genus *Nicotiana* has, in general, been considered to be a negligible factor so far as the interpretation of breeding experiments with tobacco is concerned. The only outstanding instance in which castrated or mutilated tobacco flowers have yielded viable seed is to be found in a report describing the experiments of Mrs. R. H. Thomas.[1] Her experiments, apparently conducted with due regard to the various sources of error, indicate that for her cultures parthenogenesis in various species and hybrids of *Nicotiana* is of frequent occurrence. Conflicting evidence is furnished by the experiments of others. Thus, Howard,[2] following experiments which involved the emasculation of over 5000 flowers on many strains of Indian Tobacco, found but five capsules containing seed and in only two cases was it shown that this seed was viable. Hartley[3] obtained two capsules of seed 'by treating fully receptive stigmas with magnesium sulphate,' employing in his experiments flowers of 'Cuban Tobacco (*Nicotiana Tabacum*).' The seeds thus produced proved, however, to be nothing more than empty shells. Further, East[4] and Wellington[5] claim that hybrid seed, produced by crosses between certain species of *Nicotiana*, has given plants 'like the mother species and also true hybrids,' plants 'like the mother species and no true hybrids,' and that this seed gave 'no true hybrids on one occasion but did produce true hybrids on other occa-

sions.' Certain species-crosses in *Nicotiana* made by Gärtner, also, gave seed that produced the mother species as well as true hybrids. These latter observations have been explained by the assumption that cross pollinations, 'by the extraordinary irritation of foreign pollen' (East, l.c.), may induce an apogamic or parthenogenetic development of a portion of or all of the ovules affected. Wellington, by a variety of stimulations and irritations of immature tobacco flowers was able to produce 'some abortive seed without embryos' while from a considerable number of simple castrations of buds, viable seed was produced in only one doubtful case. Our own results, based upon over 1500 castrations of tobacco flowers, borne on many species and varieties of *Nicotiana* in the University of California Botanical Garden, are entirely negative. No viable seed without pollination has been produced and in the appearance of numerous hybrid progenies we have, in no case, had reason to assume the production of apogamic or parthenogenetic seed as a result of cross pollination.

On the assumption, then, that errors of technique will not entirely account for the results which Mrs. Thomas obtained, it appeared possible that the production of viable seed without pollination was actually peculiar to certain of the particular strains of tobacco which she possessed. Faulty technique has been the only explanation offered to account for the unusual results which Mrs. Thomas reported while, so far as I know, no one has attempted to repeat her experiments with the strains of tobacco she used. Seed of the *Nicotiana Tabacum* variety, described in her paper as a frequent producer of seed without pollination, was kindly sent me by Mrs. Thomas. On plants from this same seed Bateson[6] confirmed Mrs. Thomas' results. The seed was received under the name '*Nic. tabaccum* Cuba' and represented a portion of the original seed 'gathered in the Garden of Casa Loring at Malaga in 1908.' Ninety-five plants were grown from this seed during 1914. The stand was entirely uniform and the plants were taller than and as vigorous as any of the *N. Tabacum* varieties in our cultures (cf. Setchell[7]). As described by Mrs. Thomas (loc. cit.) they are white-flowered plants, considerable numbers of four-parted flowers being produced especially at the opening of the flowering season. In vegetative characters they resemble the commercial types collectively known as 'Cuban Tobacco.'

Eight hundred buds on these ninety-five plants of '*Nic. tabaccum* Cuba' were treated according to one of the following methods—(1) simple emasculation of the flower by picking off the anthers near the tops of the filaments, (2) castration of the bud plus the pinching off, with the forceps, of the stigma at the very top of the style and (3) pinch-

ing off the stigma in the bud without the removal of the anthers. The crushed tip of the style in such cases dries down considerably before the flower matures or pollen is shed. The last two types of treatment, (2) and (3), will be referred to as 'mutilations.' In addition a few decapitation experiments were attempted (cf. Thomas, l.c.). The number of simple emasculations far exceeded the other two types of treatment.

The length of every bud treated was noted by a measurement from the point of union of calyx and pedicel to the tips of the folded corolla lobes. The maximum length of unopened buds was 49 mm. and, with the exception of a few late flowers, the anthers do not open until the corolla lobes begin to open back. The number of the flower parts was, also, determined for each bud on the supposition that four-parted and five-parted flowers might give different results following emasculation or mutilation. Finally, the records were so kept that the position on the plant of a given treated bud can be determined from the field notes—i.e., whether it occurred on the terminal inflorescence, on one of the upper 'bald suckers', or on one of the lower leafy laterals. More than one bud was often treated and bagged on a single inflorescence but in most cases such a group of buds were all of approximately the same length.

To obviate the possibility that grosser errors of technique could affect the results of the various treatments, the corollas of treated flowers were carried along with the seed bags and are, in most cases, still available for examination. If, in castration, an anther is overlooked the fact is at once noted when the withered corollas are examined both at the time of cleaning and at the time of sowing the seed produced. In only one case among the 800 treatments were anthers overlooked and a considerable amount of viable seed resulted. This check upon the results of castration and mutilation experiments is, to my mind, imperative. Willingness to discard all treatments concerning which there is the slightest doubt as to purity, is the only security obtainable in the finer details of performing the emasculations or mutilations. Despite the sterilization of instruments a bud was discarded if the forceps touched the stigma during any operation. Similarly, though only the middle one-third of the corolla tube was opened to admit the forceps, the too-close proximity of open flowers on neighboring inflorescences at the moment of treatment caused the discarding of the bud being operated upon. In addition to the 800 castrations and mutilations considered unimpeachable, 150 doubtful treatments were thrown away. The results, in the case of a few doubtful treatments which were saved, showed the necessity of such rigid discrimination.

Following the castration or mutilation of these 800 buds, there were 112 bags, involving nearly 200 flowers, in which one or more fruits developed to normal size. These fruits contained matured seed all of which was normal in appearance, though the majority was small in size, and a small proportion of which was normal in every way including the presence of endosperm and embryos. That there is a ready and frequent parthenocarpy, taking this term simply to indicate the production of normal fruits without pollination, in '*Nic. tabaccum* Cuba' there can be no doubt. This is the more remarkable since other Nicotiana species and varieties uniformly exhibit an early dropping of those flowers in which emasculation is not closely followed by pollination. It may be noted that, of the castrations and mutilations which were followed by the production of normal fruits, 75% were on the terminal inflorescence and the four or five 'bald suckers,' normal to this variety of *N. Tabacum*, and 25% only were on the lower leafy laterals. Similarly, buds treated within two weeks after the opening of the first flower on the plant matured fruits in 65 instances as compared with 57 instances in the case of treatments performed after that period. Certain plants were not treated until they had passed their first and heaviest flowering period. Such plants gave no significant increase in the proportion of fruits matured after treatment. The number of fruits matured from treated buds under 35 mm. in length was almost identical with the number produced from treated buds more than 35 mm. long. Almost equal numbers of four-parted and five-parted flowers produced fruits following treatment. However, seed containing endosperm and embryos or endosperm only seems to have resulted, in nearly all cases, from the treatment of the more normally formed, five-parted flowers. Similarly, the use of a single bud on an inflorescence for treatment seems, as was perhaps to be expected, to have been more efficient for the production of normal seed than the castration of more than one. Of the total 800 treatments less than one-third involved the pinching off of the stigma in addition to emasculation. Approximately one-tenth of the total number involved the pinching off of the stigma only. Nine treated flowers produced a little viable seed and, of these nine flowers, three represent treatments in which the stigma was removed.

The great majority of the seed produced in the parthenocarpic fruits was normal in appearance and well filled out but these seeds were smaller than the self-pollinated seeds and consisted of empty seed coats only. Samples of seed from each seed packet were bleached in strong Eau de Javelle and examined under magnification. Controls were em-

ployed in which self-fertilized seed of '*Nic. tabaccum* Cuba' was similarly treated. Three types of seed were isolated, according to this method, from the parthenocarpic fruits. First, seed which consisted of nothing but empty seed-coats normal in structure and completely filled out. Second, seed of the first type which contained traces of endosperm but no embryos.[9] Such endosperm tissue occurred as a sheath of cells lining the seed-coat or as a mass of cells at one end of the seed, the contents of which was rich in starch. These first two types were small seeds. The third type of seed isolated was identical with the self-pollinated seed both in size and in the possession of normally developed endosperm and full sized embryos. Seeds of type one were overwhelmingly in the majority in every case and the total number of seeds shown to be in every way normally matured, either by examination under the microscope or by the fact that they produced normal seedlings, was approximately thirty-five. They were produced, along with empty seeds and seed containing endosperm only, in approximately equal numbers in the nine parthenocarpic fruits. Four seedlings are maturing normally and are of fair size from nine seeds which were germinated out of a total of eighteen seeds available for germination. The eighteen seeds represent the proportion of the fifty undoubtedly viable seeds not used in the bleaching test.

We may conclude, then, that parthenocarpy is of frequent occurrence in '*Nic. tabaccum* Cuba' and that parthenogenesis, employing the term to mean the production of viable seed without pollination (cf. Winkler[8]), is also peculiar to this variety of *N. Tabacum.* With these unusual phenomena manifesting themselves during this first year of cultivation in our cultures I feel that there is a possibility, at least, that after further cultivation here parthenogenesis and parthenocarpy may become more nearly equal in the frequency of their occurrence. The experimental results above described should furnish a partial confirmation of those reported by Mrs. Thomas for her experiments on '*Nic. tabaccum* Cuba.' Nothing that has been said, however, must suggest that I desire to confirm her general results on the basis of which she concludes that parthenogenesis is peculiar to *Nicotiana* species in general. It must, on the contrary, be emphasized that our experiments, with all other species and varieties of tobacco, and those of a number of other investigators, point to exactly the reverse conditions and that we have no reason to suppose that parthenogenesis has ever before occurred in our cultures. I have no suggestion to offer, at the present time, as to the possible origin of this *Nicotiana tabacum* variety which exhibits

such marked divergence from the restricted method of fruit and seed production peculiar to other varieties of this species and to all other species of tobacco as far as known.

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[3] Hartley, *U. S. Dept. Agric., Bur. Plant Ind., Bull.*, No. 20.
[4] East, *Pop. Sci. Mon.*, 1910.
[5] Wellington, *Amer. Nat.*, vol. 47, No. 557.
[6] Bateson, *4th Conf. Inter. Gen.*
[7] Setchell, *Univ. Cal. Pub. Bot.*, vol. 5, No. 1.
[8] Winkler, *Prog. rei. Bot.*, Bd. 2, H. 3.
[9] de Vries, *Bot. Gaz., Chicago*, 59, 190.

EXOGAMY AND THE CLASSIFICATORY SYSTEM OF RELATIONSHIP

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Lewis H. Morgan, in his *Systems of Consanguinity and Affinity* (Washington, 1871), established the fact that in a large part of North America, in India, in Africa, and in Oceania the natives use terms of relationship that designate not individuals but groups of individuals, and accordingly he labeled these systems as 'classificatory.' Later E. B. Tylor and others advanced the view that the classificatory system and exogamy—the rule that a person must marry outside of his own social group (clan or gens)—were merely two aspects of a single institution: that, in other words, primitive man classed together individuals belonging to the same exogamous division and separated individuals of different divisions. Quite recently this view has been advocated by W. H. R. Rivers. In his *Kinship and Social Organisation* (London, 1914) he correlates the classificatory system with exogamy, our own system with the family in the narrower sense of the term, and the descriptive system of, say, the Nilotic Negroes (in which a few primary terms designate the basic relationships and serve by their combination to describe all other relatives) with the patriarchal or extended family. The correlation of